



**National Education Policy -2020**  
**Common Minimum Syllabus for All U P State Universities and Colleges**  
**For First Three Years of Higher Education**

**Subject-Biotechnology**  
**( For Three Subject Pattern)**

| Name                                                          | Designation                                  | Affiliation                                                     |
|---------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------|
| <b>Steering Committee</b>                                     |                                              |                                                                 |
| Mrs. Monika S. Garg (IAS),<br>Chairperson, Steering Committee | Additional Chief<br>Secretary                | Deptt. of Higher Education,<br>U.P., Lucknow                    |
| Prof Poonam Tandan                                            | Professor,<br>Deptt. of Physics              | Lucknow University,<br>Lucknow, U.P.                            |
| Prof Hare Krishna                                             | Professor<br>Deptt. of Statistics            | CCS University, Meerut, U.P.                                    |
| Dr Dinesh C. Sharma                                           | Associate Professor                          | K. M. Govt. Girls PG<br>College, Badalpur, G. B.<br>Nagar, U.P. |
| <b>Supervisory Committee- Science Faculty</b>                 |                                              |                                                                 |
| Dr Vijay Kumar Singh                                          | Associate Professor,<br>Deptt. of Zoology    | Agra College, Agra                                              |
| Dr Santosh Singh                                              | Dean,<br>Deptt. of Agriculture               | Mahatama Gandhi Kashi<br>Vidyapeeth, Varanasi, U.P.             |
| Dr Baby Tabussam                                              | Associate Professor,<br>Deptt. of Zoology    | Govt. Raza PG College<br>Rampur, U. P.                          |
| Dr Sanjay Jain                                                | Associate Professor,<br>Deptt. of Statistics | St. John's College, Agra                                        |

**Syllabus Developed by-**

| S<br>No. | Name             | Designation            | Department    | Institution                                                                      |
|----------|------------------|------------------------|---------------|----------------------------------------------------------------------------------|
| 1        | Dr Vandana Rai   | Professor              | Biotechnology | V B S Purvanchal University,<br>Jaunpur;<br>e-mail:<br>raivandana@rediffmail.com |
| 2        | Dr Pradeep Kumar | Associate<br>Professor | Biotechnology | V B S Purvanchal University,<br>Jaunpur;<br>e-mail: pradipk14@yahoo.co.in        |
| 3        | Dr Saras         | Assistant<br>Professor | Zoology       | DAV (PG) College, Kanpur                                                         |

| SEMESTER WISE PAPER TITLES WITH DETAILS                                  |          |             |                                                      |                      |         |
|--------------------------------------------------------------------------|----------|-------------|------------------------------------------------------|----------------------|---------|
| Year                                                                     | Semester | Course Code | Paper Title                                          | Theory/<br>Practical | Credits |
| CERTIFICATE COURSE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY |          |             |                                                      |                      |         |
| First Year                                                               | I        | B100101T    | Cell Biology and Genetics                            | Theory               | 4       |
|                                                                          |          | B100102P    | Cell Biology and Genetics Lab                        | Practical            | 2       |
|                                                                          | II       | B10 0201T   | Molecular Biology and Genetic Engineering            | Theory               | 4       |
|                                                                          |          | B100202P    | Genetic Engineering Lab                              | Practical            | 2       |
| DIPLOMA IN TOOLS AND TECHNIQUES OF BIOTECHNOLOGY                         |          |             |                                                      |                      |         |
| Second Year                                                              | III      | B100301T    | Biochemistry and Biochemical tools                   | Theory               | 4       |
|                                                                          |          | B10 0302 P  | Biochemistry Lab                                     | Practical            | 2       |
|                                                                          | IV       | B10 0401T   | Microbiology and Immunology                          | Theory               | 4       |
|                                                                          |          | B10 0402 P  | Microbiology and Immunology Lab                      | Practical            | 2       |
| DEGREE IN BACHELOR OF SCIENCE                                            |          |             |                                                      |                      |         |
| Third Year                                                               | V        | B10 0501 T  | Biostatistics and Bioinformatics                     | Theory               | 4       |
|                                                                          |          | B100502T    | Animal and Plant Biotechnology                       | Theory               | 4       |
|                                                                          |          | B10 0503P   | Bioinformatics, Biostatistics and Tissue culture Lab | Practical            | 2       |
|                                                                          | VI       | B100601T    | Industrial and Environmental Biotechnology           | Theory               | 4       |
|                                                                          |          | B100602T    | Food Biotechnology                                   | Theory               | 4       |
|                                                                          |          | B100603P    | Industrial and Environmental Biotechnology Lab       | Practical            | 2       |

| <b>Subject Prerequisite</b>                                                                                                                                                                           |                                                                                                                                                                                                                                                      |
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| The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject. |                                                                                                                                                                                                                                                      |
| <b>Programme Outcomes (POs)</b>                                                                                                                                                                       |                                                                                                                                                                                                                                                      |
| After completion of the B. Sc. Biotechnology programme, the candidate should be able to:                                                                                                              |                                                                                                                                                                                                                                                      |
| <b>PO1</b>                                                                                                                                                                                            | Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology research, Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia. |
| <b>PO2</b>                                                                                                                                                                                            | Demonstrate skills to use modern analytical tools/ software/ equipment and analyse and solve problems in various courses of biotechnology.                                                                                                           |
| <b>PO3</b>                                                                                                                                                                                            | Execute their professional roles in society as biotechnology professionals, employers and employees in various industries, researchers and educators.                                                                                                |
| <b>PO4</b>                                                                                                                                                                                            | Design, perform experiments, analyse and interpret data for investigating complex problems in biotechnology and related fields.                                                                                                                      |
| <b>PO5</b>                                                                                                                                                                                            | Demonstrate learning skills to work as a team in a multidisciplinary environment.                                                                                                                                                                    |
| <b>PO6</b>                                                                                                                                                                                            | Design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.                                                                                                                                   |
| <b>PO7</b>                                                                                                                                                                                            | Develop skills, attitude and values required for self-directed, lifelong learning and professional development.                                                                                                                                      |
| <b>PO8</b>                                                                                                                                                                                            | Acquire knowledge and understanding of norms and ethics in the field of biotechnology.                                                                                                                                                               |

| <b>PROGRAMME SPECIFIC OUTCOMES (PSOS)</b>                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CERTIFICATE IN TOOLS AND TECHNIQUES OF CELL AND MOLECULAR BIOLOGY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>First Year</b>                                                        | <p>This course introduces the knowledge of cell biology, genetics, molecular biology and genetic engineering. After completion of this certificate course, students will be able to –</p> <p><b>PSO1:</b> demonstrate and apply their knowledge of cell biology, genetics, molecular biology and genetic engineering to solve the problems related to the field of biotechnology</p> <p><b>PSO2:</b> gain knowledge about the application of various types of microscope, karyotyping, banding techniques, chromosome painting and FACS.</p> <p><b>PSO3:</b> understand the basic concepts of genetics and molecular biology such as inheritance pattern, DNA replication, transcription and translation</p> <p><b>PSO4:</b> understand and perform various recent molecular and recombinant DNA technology techniques in early diagnosis and prognosis of human diseases.</p> <p><b>PSO5:</b> perform experiments of DNA isolation, agarose gel electrophoresis, gene cloning, transformations, protein expression and purification. This</p> |

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|                                                        | <p>experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.</p> <p><b>PSO6:</b> apply at technical positions in different research laboratories, diagnostic centres and industries.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>DIPLOMA IN TOOL AND TECHNIQUES IN BIOTECHNOLOGY</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Second Year</b>                                     | <p>After completion of diploma course, students will be able to-</p> <p><b>PSO1:</b> familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.</p> <p><b>PSO2:</b> understand the significance of Biochemistry and basics of enzymes.</p> <p><b>PSO3:</b> learn the chemistry, structure and functions of major bio-molecules and metabolism of carbohydrate, protein etc.</p> <p><b>PSO4:</b> understand different biochemical tools and techniques such as chromatography, electrophoresis, X-ray diffraction, NMR and mass spectrometry</p> <p><b>PSO5:</b> perform different experiments based on the techniques such as chromatography, electrophoresis, centrifugation etc.</p> <p><b>PSO6:</b> understand the different methods of sterilization</p> <p><b>PSO7:</b> understand and also able to perform different immunological techniques like agglutination reaction, ABO typing and ELISA.</p>                                                                                                                                                                                                                   |
| <b>DEGREE IN BACHELOR OF SCIENCE</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Third Year</b>                                      | <p>After completing the three years degree course in Biotechnology, the students will be able to –</p> <p><b>PSO1:</b> demonstrate the concepts in computational Biology. Understand the interrelationship between Biology and Computer</p> <p><b>PSO2:</b> acquire knowledge in different domains of biotechnology enabling their application in industry, research and academia.</p> <p><b>PSO3:</b> perform and analyse the results of experiments using basic laboratory techniques of cell biology, molecular biology, genetic engineering, biochemistry, immunology, microbiology, bioinformatics, biostatistics, animal and plant biotechnology and Food biotechnology.</p> <p><b>PSO4:</b> recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant technology.</p> <p><b>PSO5:</b> develop an ability to properly understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.</p> <p><b>PSO6:</b> exhibit ability to do research independently as well as in collaboration.</p> <p><b>PSO7:</b> recognize the importance of Bioethics, IPR, and entrepreneurship.</p> |

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| <b>Programme/Class:</b> Certificate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Year:</b> First (1)                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Semester:</b> First (I) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |
| <b>Couse Code:</b> B100101T                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Course Title:</b> Cell Biology and Genetics                                                                                                                                                                                                                                                                                                                                                                                                           |                            |
| <b>Course Outcomes (COs)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |
| This course introduces the principles of cell biology and genetics. After completion of this course, students will be able to- <ul style="list-style-type: none"><li>• learn different areas of cell biology including the structure and functions of cell, its organelles such as mitochondria, nucleus etc.</li><li>• understand how genetic information is transmitted in organism.</li><li>• understand the role of cytoskeleton and its remodelling including the diseases associate with improper remodelling.</li><li>• earn how the synthesized proteins are transported to different organelles.</li><li>• understand the regulation of cell cycle, programmed cell death and Cancer.</li><li>• learn different cell biology techniques like karyotyping, chromosome banding, FISH, FACS, centrifugation and microscopy.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |
| <b>Credits:</b> 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |                            |
| <b>Maximum Marks: 100</b><br><b>(75(UE)+25(CIE))</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                    |                            |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |
| <b>Unit</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Topics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>N0. of Lectures</b>     |
| <b>I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"><li>• Introduction and history of Biotechnological science with special reference to contribution of Indian scholars in biological sciences</li></ul>                                                                                                                                                                                                                                                                  | 2                          |
| <b>II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"><li>• Prototype structure of animal, plant and bacterial cells, Diversity of cell size and shape</li><li>• Cell theory</li><li>• C-value paradox</li><li>• Cell Membrane: Chemical components of biological membranes, organization and Fluid Mosaic Model, and membrane transport.</li><li>• Cytoskeleton and Extra cellular matrix</li></ul>                                                                         | 8                          |
| <b>III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Structure and Function of Cell organelles:</b> <ul style="list-style-type: none"><li>• Lysosomes: Vacuoles and micro bodies: Structure and functions</li><li>• Ribosomes: Structures and function including role in protein synthesis.</li><li>• Mitochondria: Structure and function, Genomes, biogenesis.</li><li>• Chloroplasts: Structure and function, genomes, biogenesis</li><li>• Nucleus: Structure and function, nuclear envelope</li></ul> | 9                          |
| <b>IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Chromosome structure:</b> <ul style="list-style-type: none"><li>• Chromosomes: chromatin and chromosomes organization, euchromatin and heterochromatin, nucleosome, metaphase chromosome, genes and</li></ul>                                                                                                                                                                                                                                         | 9                          |

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|      | <p>chromosomes.</p> <ul style="list-style-type: none"> <li>• DNA as genetic material, Structure of DNA</li> <li>• Structural and numerical changes in human chromosomes and ploidy in plants.</li> <li>• Mutations: Types of mutations, spontaneous and induced mutations, Physical and chemical mutagens</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |
| V    | <p><b>Cell cycle, Cancer and Cell Signaling:</b></p> <ul style="list-style-type: none"> <li>• Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast and higher organisms</li> <li>• Cell senescence and programmed cell death</li> <li>• Cancer – chromosomal disorders, oncogenes and tumor suppressor genes</li> <li>• Introduction to cell signalling and cell –cell interaction</li> </ul>                                                                                                                                                                                                                                                                                                                                    | 7 |
| VI   | <p><b>Mendelian and nonmendelian genetics:</b></p> <ul style="list-style-type: none"> <li>• Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance</li> <li>• Mendelian genetics : Mendel’s experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation &amp; Principle of independent assortment</li> <li>• Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy</li> <li>• Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory</li> </ul> | 8 |
| VII  | <p><b>Linkage, crossing over and population genetics:</b></p> <ul style="list-style-type: none"> <li>• Linkage, crossing-over and chromosome and genetic mapping</li> <li>• Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.</li> <li>• Genetic Code: deciphering genetic code; degeneracy, unusual codons in mitochondria Mutations: types, mechanisms</li> <li>• Evolution and population genetics: Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, evolutionary genetics, natural selection.</li> </ul>                                                           | 8 |
| VIII | <p><b>Cytological techniques:</b></p> <ul style="list-style-type: none"> <li>• Microscopy and staining techniques</li> <li>• Microtomy</li> <li>• Karyotyping</li> <li>• Chromosome banding,</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 9 |

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| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., &amp; Walter, P. (2014). <b>Molecular Biology of the Cell</b> (6th Ed.). New York: Garland Science</li> <li>2. Cooper, G. M., and Hausman, R. E. (2013). <b>The Cell: a Molecular Approach</b> (6th Ed.). Washington: ASM ; Sunderland.</li> <li>3. Karp, G. <b>Cell and Molecular Biology. Concepts and experiments</b>. John Harris, D., Wiley &amp; sons, New York</li> <li>4. Iwasa J., Marshal W. <b>Karp's Cell Biology</b>(2018) (8<sup>th</sup> edition) Wiley &amp; Sons, NY</li> <li>5. Iwasa J., Marshal W. <b>Karp's Cell and Molecular Biology</b> . Concepts and experiments. (2015) (8<sup>th</sup> edition) Wiley &amp; sons, New York</li> <li>6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). <b>Molecular Biology of the Gene</b> (5th ed.). Pearson</li> <li>7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). <b>Molecular Cell Biology</b> (8th Ed.). New York: W.H. Freeman</li> <li>8. Gupta P.K. <b>Cell and Molecular Biology</b> 2018. 5<sup>th</sup> edition Rastogi Publication India.</li> <li>9. Hartl, D. L., &amp; Jones, E. W. (1998). <b>Genetics: Principles and Analysis</b>. Sudbury, MA: Jones and Bartlett.</li> <li>10. Pierce, B. A. (2005). <b>Genetics: a Conceptual Approach</b>. New York: W.H. Freeman.</li> <li>11. Tamarin, R. H., &amp; Leavitt, R. W. (1991). <b>Principles of Genetics</b>. Dubuque, IA: Wm. C. Brown.</li> <li>12. Smith, J. M. (1998). <b>Evolutionary Genetics</b>. Oxford: Oxford University Press</li> <li>13. Gardner EJ, Simmons MJ, Sunstad DP. <b>Principles of Genetics</b>. 8<sup>th</sup> Edition. John Wiley and Sons.</li> <li>14. Snustand DP, Simmons MJ. <b>Principles of Genetics</b>. (2016) 7<sup>th</sup> Edition. John Wiley and Sons.</li> <li>15. Verma PS, Agarwal VK. <b>Cell Biology, Genetics, Molecular Biology, Evolution and Ecology</b>. (2004). S Chand and Company Ltd.</li> <li>16. Satyanarayana U (2020). <b>Biotechnology</b>. Books and Allied (P) Ltd</li> <li>17. Singh BD. (2015). <b>Biotechnology: Expanding Horizons</b> (4<sup>th</sup> edition). Kalyani Publishers</li> <li>18. Dubey RC. (2014) <b>A Textbook of Biotechnology</b>(5<sup>th</sup> edition) S Chand and Company Ltd.</li> <li>19. सिंह बी डी (2017) <b>बायोटेक्नोलोजी</b> Kalyani Publishers</li> <li>20. पी के गुप्ता, <b>कोशिका विज्ञान एवम अनुवांशिकी</b>, 2015 2<sup>nd</sup> edition Rastogi Publications</li> <li>21. सिंह बी डी, <b>आनुवांशिकी के आधार</b>. (2017) Kalyani Publishers</li> <li>22. सोनी के सी, <b>स्वरंकार गायत्री. आधुनिक कोशिका विज्ञान</b>, 2018 CBC</li> </ol> <p><b>Other course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                         |  |
| <p style="text-align: center;"><b>Suggested link</b></p> <ul style="list-style-type: none"> <li>• <a href="https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=cellbiology">https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=cellbiology</a></li> <li>• <a href="https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=genetics">https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=genetics</a></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                         |  |

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| <ul style="list-style-type: none"> <li>• <a href="https://nptel.ac.in/courses/102/103/102103012/">https://nptel.ac.in/courses/102/103/102103012/</a></li> <li>• <a href="https://nptel.ac.in/courses/102/106/102106025/">https://nptel.ac.in/courses/102/106/102106025/</a></li> <li>• <a href="https://nptel.ac.in/courses/102/103/102103015/">https://nptel.ac.in/courses/102/103/102103015/</a></li> </ul> |
| <b>Suggested Digital platform/Web link</b>                                                                                                                                                                                                                                                                                                                                                                    |
| <p align="center"><b>Course prerequisite</b></p> <p>The candidate should have passed (10+2) examination in science stream with PCB (Physics ,Chemistry, Biology and/or Biotechnology) or PCM (Physics , Chemistry and Maths) or any other science subject.</p>                                                                                                                                                |
| <p align="center"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total marks: 25</b><br/> 10 marks for Test<br/> 10 marks for presentation along with assignment<br/> 05 marks for Class interactions</p>                                                                                                                                                                            |
| <b>Further Suggestions: None</b>                                                                                                                                                                                                                                                                                                                                                                              |

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| <b>Programme/Class:</b> Certificate                                                                                                                                                                                                                                                                                                            | <b>Year:</b> First (1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Semester:</b> First (I) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| <b>Couse Code:</b> B100102P                                                                                                                                                                                                                                                                                                                    | <b>Course Title:</b> Cell Biology and Genetics Lab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                            |
| <b>Course Outcomes (COs)</b>                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| After completion of this course, students will be able to- <ul style="list-style-type: none"><li>• learn, understand and develop skill and hands on training in basics of cell biology and genetics.</li><li>• be able to differentiate between plant and animal cells</li><li>• be analysed different stages of mitosis and meiosis</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| <b>Credits:</b> 2                                                                                                                                                                                                                                                                                                                              | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                            |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                  | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                            |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4</b>                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
|                                                                                                                                                                                                                                                                                                                                                | <b>Topics</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>No. of Lectures</b>     |
|                                                                                                                                                                                                                                                                                                                                                | <ol style="list-style-type: none"><li>1. Introduction to safety measures in Laboratories</li><li>2. Preparation of solutions and buffers</li><li>3. Equipment handling and pipetting</li><li>4. Study of structure of any Prokaryotic and Eukaryotic cell.</li><li>5. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney etc.</li><li>6. Cell division in onion root tip/ insect (grasshopper) gonads.</li><li>7. Vital Staining of Mitochondria with Janus green B.</li><li>8. Demonstration of diversity of cell types (Muscle, Neuron)</li><li>9. Demonstration of Sex chromatin in buccal smear.</li></ol> | 60                         |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 10. Karyotype preparation.<br>11. Preparation of polytene chromosomes from salivary gland of Chironomous larvae.<br>12. Genetics problems based on : (i) Mendel's law (ii) Gene mapping and (iii) Transposable elements.<br>13. Ames test for mutagenesis.<br>14. Genetic experiment – Drosophila model |  |
| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., &amp; Walter, P. (2014). <b>Molecular Biology of the Cell</b> (6th Ed.). New York: Garland Science</li> <li>2. Cooper, G. M., and Hausman, R. E. (2013). <b>The Cell: a Molecular Approach</b> (6th Ed.). Washington: ASM ; Sunderland.</li> <li>3. Karp, G. <b>Cell and Molecular Biology. Concepts and experiments</b>. John Harris, D., Wiley &amp; sons, New York</li> <li>4. Iwasa J., Marshal W. <b>Karp's Cell Biology</b>(2018) (8<sup>th</sup> edition) Wiley &amp; Sons, NY</li> <li>5. Iwasa J., Marshal W. <b>Karp's Cell and Molecular Biology</b> . Concepts and experiments. (2015) (8<sup>th</sup> edition) Wiley &amp; sons, New York</li> <li>6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). <b>Molecular Biology of the Gene</b> (5th ed.). Pearson</li> <li>7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). <b>Molecular Cell Biology</b> (8th Ed.). New York: W.H. Freeman</li> <li>8. Gupta P.K. <b>Cell and Molecular Biology</b> 2018. 5<sup>th</sup> edition Rastogi Publication India.</li> <li>9. Hartl, D. L., &amp; Jones, E. W. (1998). <b>Genetics: Principles and Analysis</b>. Sudbury, MA: Jones and Bartlett.</li> <li>10. Roskam's J. Rodgers L.(2002). <b>Lab Ref: A Handbook of Recipes, Reagents, and other reference tools for use at the Bench</b>. Cold Spring Harbor Laboratory Press. USA.</li> <li>11. Barker K (2004). <b>At the Bench: A laboratory Navigator</b>. Cold Spring Harbor Laboratory Press. USA</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> <p style="text-align: center;"><b>Course prerequisite</b></p> <p>The candidate should have passed (10+2) examination in science stream with PCB (Physics ,Chemistry, Biology and/or Biotechnology) or PCM (Physics , Chemistry and Maths) or any other science subject.</p> <p style="text-align: center;"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total marks: 25</b><br/> 10 marks for Test<br/> 10 marks for presentation along with assignment<br/> 05 marks for Class interactions</p> <p><b>Further Suggestions: None</b></p> |                                                                                                                                                                                                                                                                                                         |  |

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| <b>Programme/Class:</b> Certificate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Year:</b> First (1)                                                                                                                                                                                                                                                                                                                                                                                      | <b>Semester:</b> Second (II) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                             |                              |
| <b>Couse Code:</b> B100201T                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Course Title:</b> Molecular Biology and Genetic Engineering                                                                                                                                                                                                                                                                                                                                              |                              |
| <b>Course Outcomes (COs)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                             |                              |
| Student will be able to- <ul style="list-style-type: none"><li>• learn and understand the important discoveries that are made in the field of molecular biology.</li><li>• learn key molecular events that occur during the DNA replication, transcription, translation and regulation of gene concept.</li><li>• gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.</li><li>• understand gene concept, plasmids, and wide range of techniques, especially modern molecular tools in diagnosis.</li><li>• acquainted with various techniques of genetic engineering and their applications in biological research, diagnostics as well as in biotechnology industries.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                             |                              |
| <b>Credits:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                      |                              |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                       |                              |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                             |                              |
| <b>Unit</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                | <b>No. of Lectures</b>       |
| <b>I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Gene organization and regulation of gene expression:</b> <ul style="list-style-type: none"><li>• Structure of DNA, Types of DNA</li><li>• Gene organization in prokaryotes and eukaryotes, polycistronic genes, split genes promoters, enhancers.</li><li>• Regulation of gene expression: Prokaryotes: lac and trp operons in <i>E. coli</i>.</li></ul>                                                 | 7                            |
| <b>II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>DNA Replication and DNA polymerases:</b> <ul style="list-style-type: none"><li>• Replication of genetic material in prokaryotes and eukaryotes</li><li>• A brief description of initiation at replication origins and its cell cycle regulation.</li><li>• Structure and function of prokaryotic and eukaryotic DNA polymerases</li></ul>                                                                | 7                            |
| <b>III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Transcription and mRNA processing:</b> <ul style="list-style-type: none"><li>• RNA structure and types of RNA</li><li>• Mechanism of transcription in prokaryotes and eukaryotes: transcription factors, structure of prokaryotic and eukaryotic RNA polymerases, initiation, elongation and termination.</li><li>• RNA processing: processing of mRNA (Splicing, capping and polyadenylation)</li></ul> | 8                            |
| <b>IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Prokaryotic and eukaryotic translation:</b> <ul style="list-style-type: none"><li>• Ribosome structure and assembly, tRNA, aminoacyltRNA synthetases,</li><li>• Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of</li></ul>                                                                                                                    | 7                            |

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|             | translation.<br>• Posttranslational modifications of proteins.                                                                                                                                                                                                                                  |   |
| <b>V</b>    | <b>Vectors:</b><br>• Cloning vectors (plasmids, cosmids, bacterial artificial chromosomes and yeast artificial chromosomes),<br>• shuttle vectors,<br>• expression vectors                                                                                                                      | 7 |
| <b>VI</b>   | <b>Enzymes used in DNA manipulating:</b><br>• Restriction endonuclease<br>• Ligases<br>• Polymerases<br>• Kinases<br>• Alkaline phosphatases<br>• Reverse Transcriptase                                                                                                                         | 8 |
| <b>VII</b>  | <b>Genomic Library, PCR, Sequencing etc:</b><br>• Preparation and comparison of Genomic and cDNA library.<br>• PCR and its applications.<br>• DNA Sequencing.<br>• Site directed mutagenesis<br>• Protein engineering concepts and examples (any two).                                          | 8 |
| <b>VIII</b> | <b>Molecular Biology techniques:</b><br>• DNA isolation (Plasmid/ Genomic DNA isolation)<br>• Blotting (Southern, Northern, Western)<br>• Electrophoresis of nucleic acids and proteins<br>• Gene cloning, Screening and characterization of cloned DNA<br>• DNA Fingerprinting<br>• RFLP, RAPD | 8 |

#### Suggested Reading

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). **Molecular Biology of the Cell** (6th Ed.). New York: Garland Science
2. Cooper, G. M., and Hausman, R. E. (2013). **The Cell: a Molecular Approach** (6th Ed.). Washington: ASM ; Sunderland.
3. Karp, G. **Cell and Molecular Biology. Concepts and experiments**. John Harris, D., Wiley & sons, New York
4. Iwasa J., Marshal W. **Karp's Cell Biology**(2018) (8<sup>th</sup> edition) Wiley & Sons, NY
5. Iwasa J., Marshal W. **Karp's Cell and Molecular Biology** . Concepts and experiments. (2015) (8<sup>th</sup> edition) Wiley & sons, New York
6. Watson, J. D. Baker TA, Bell, SP Gann, A. Levine, M. Losick R. (2008). **Molecular Biology of the Gene** (5th ed.). Pearson
7. Lodish, H F. Berk, A. Kaiser, CA, Krieger, M. Bretscher, A. Ploegh, H. Aman, A. Martin, K. (2016). **Molecular Cell Biology** (8th Ed.). New York: W.H. Freeman
8. Gupta P.K. **Cell and Molecular Biology** 2018. 5<sup>th</sup> edition Rastogi Publication India.
9. Brown TA. **Gene cloning and DNA analysis: An introduction**. (2016) 7<sup>th</sup> Edition. Wiley-Blackwell
10. Old, R. W., Primrose, S. B., & Twyman, R. M. (2006). **Principles of Gene Manipulation and Genomics**, 7th Edition: Blackwell Publishing.
11. Krebs JE, Goldstein ES and Kilpatrick ST (2014) **Lewin's Gene XII**, Jones and Barlett

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| <p>Publisher</p> <p>12. Brown, T. A. (2018). <b>Genomes</b> 4.(4<sup>th</sup> edition) New York: Garland Science Pub.</p> <p>13. Green, M. R., &amp; Sambrook, J. (2014) Fourth Edition. <b>Molecular Cloning: a Laboratory Manual</b>. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.</p> <p>14. Micklos, DA &amp; Freyer, CA. <b>DNA Science: A first course in Recombinant DNA Technology</b>(2<sup>nd</sup> Edition) –Cold Spring harbor laboratory press, NY</p> <p>15. Satyanarayana U (2020). Biotechnology. Books and Allied (P) Ltd</p> <p>16. Singh BD. (2015). Biotechnology: Expanding Horizons (4<sup>th</sup> edition). Kalyani Publishers</p> <p>17. Dubey RC. (2014) A Textbook of Biotechnology(5<sup>th</sup> edition) S Chand and Company Ltd.</p> <p>18. सिंह बी डी(2017) बायोटेक्नोलोजी Kalyani Publishers</p> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> | <p><b>Suggested link</b></p> <ul style="list-style-type: none"> <li>• <a href="https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/">https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/transcription-translation/">https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/transcription-translation/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/gene-regulation-and-the-lac-operon/">https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/molecular-biology/gene-regulation-and-the-lac-operon/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/">https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/agarose-gel-electrophoresis-dna-sequencing-pcr/">https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/agarose-gel-electrophoresis-dna-sequencing-pcr/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/basic-mechanics-of-cloning/">https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/basic-mechanics-of-cloning/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/labs/mod1_3/">https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/labs/mod1_3/</a></li> <li>• <a href="https://nptel.ac.in/courses/102/103/102103045/#">https://nptel.ac.in/courses/102/103/102103045/#</a></li> </ul> |
| <p><b>Suggested Digital platform/Web link</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p><b>Course prerequisite</b></p> <p>To study this course, student must have passed semester I.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total marks: 25</b></p> <p>10 marks for Test</p> <p>10 marks for presentation along with assignment</p> <p>05 marks for Class interactions</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p><b>Further Suggestions:</b> None</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

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| <b>Programme/Class:</b> Certificate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Year:</b> First (1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Semester:</b><br>Second (II) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |
| <b>Couse Code:</b> B100202P                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Course Title:</b> Genetic Engineering Lab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                 |
| <b>Course Outcomes (COs)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |
| After completion of the course, the student shall be able to - <ul style="list-style-type: none"><li>• prepare different bacterial growth media,</li><li>• understand principals and methods of competent cell preparation, restriction digestion, gene ligation, gene cloning, and transformation i. e gene manipulation.</li><li>• understand the method of agarose electrophoresis for plasmid and genomic DNA separation</li><li>• understand the method of blotting and PCR</li></ul>                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |
| <b>Credits:</b> 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                 |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                 |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>No. of Lectures</b>          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1. Preparation of solutions for Molecular Biology experiments.<br>2. Preparation of bacterial growth medium (L.B., 2XYT)<br>3. Competent cell preparation.<br>4. Transformation of <i>E.coli.</i> cells (color selection of transformants – with or without inserts) X – gal and IPTG.<br>5. Isolation of Plasmid DNA by alkaline lysis method<br>6. Isolation of genomic DNA from bacterial cells.<br>7. Agarose gel electrophoresis of genomic DNA & plasmid DNA<br>8. Concentration estimation by agarose gel electrophoresis<br>9. Preparation of restriction enzyme digests of DNA samples<br>10. Ligation<br>11. Southern blotting<br>12. PCR | 60                              |
| <b>Suggested Reading</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |
| 1. Brown TA. <b>Gene cloning and DNA analysis: An introduction.</b> (2016) 7 <sup>th</sup> Edition. Wiley-Blackwell<br>2. Old, R. W., Primrose, S. B., & Twyman, R. M. (2006). <b>Principles of Gene Manipulation and Genomics</b> , 7th Edition: Blackwell Publishing.<br>3. Krebs JE, Goldstein ES and Kilpatrick ST (2014) <b>Lewin’s Gene XII</b> , Jones and Barlett Publisher<br>4. Brown, T. A. (2018). <b>Genomes</b> 4.(4 <sup>th</sup> edition) New York: Garland Science Pub.<br>5. Green, M. R., & Sambrook, J. (2014) Fourth Edition. <b>Molecular Cloning: a Laboratory Manual.</b> Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.<br>6. Micklos, DA & Freyer, CA. <b>DNA Science: A first course in Recombinant DNA</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 |

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| <p><b>Technology</b> (2<sup>nd</sup> Edition) –Cold Spring Harbor laboratory press, NY</p> <p>7. Roskam's J. Rodgers L.(2002). <b>Lab Ref: A Handbook of Recipes, Reagents, and other reference tools for use at the Bench.</b> Cold Spring Harbor Laboratory Press. USA.</p> <p>8. Barker K(2004). <b>At the Bench: A laboratory Navigator.</b> Cold Spring Harbor Laboratory Press. USA</p> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |
| <p style="text-align: center;"><b>Course prerequisite</b></p> <p>To study this course, student must have passed semester I.</p>                                                                                                                                                                                                                                                                                                                                                          |
| <p style="text-align: center;"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total Marks: 25</b></p> <p>10 marks for Test</p> <p>10 marks for presentation along with assignment</p> <p>05 marks for Class interactions</p>                                                                                                                                                                                                                                    |
| <p><b>Further Suggestions:</b> None</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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| <b>Programme/Class:</b> Diploma                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Year:</b> Second (2)                                 | <b>Semester:</b> Third (III) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                         |                              |
| <b>Couse Code:</b> B100301T                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Course Title:</b> Biochemistry and Biochemical tools |                              |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                         |                              |
| After successful completion of the course, student will be able to: <ul style="list-style-type: none"><li>• understand the significance of Biochemistry.</li><li>• learn the chemistry of carbohydrates, lipids, proteins and amino acids.</li><li>• understand the basics of enzymes.</li><li>• understand the metabolism of carbohydrate and proteins</li><li>• know the chemical structure of nucleotides including their components , describe primary, secondary structure of DNA and RNA.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                         |                              |
| <b>Credits:</b> 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Core Compulsory</b>                                  |                              |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Minimum Passing Marks:</b> As per University norms   |                              |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0</b>                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                         |                              |
| <b>Unit</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                |                                                         | <b>No. of Lectures</b>       |
| <b>I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Amino acids and Protein:</b> <ul style="list-style-type: none"><li>• Structure and properties of Amino acids</li><li>• Types of proteins and their classification</li><li>• Forces stabilizing protein structure.</li><li>• Different Level of structural organization of proteins.</li><li>• Denaturation and renaturation of proteins.</li></ul>                                                                       |                                                         | 7                            |
| <b>II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Carbohydrates:</b> <ul style="list-style-type: none"><li>• Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides.</li><li>• Homo and Hetero Polysaccharides, Mucopolysaccharides,</li><li>• Bacterial cell wall polysaccharides, Glycoprotein’s and their biological functions.</li></ul>                                                                                             |                                                         | 7                            |
| <b>III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Nucleic acids:</b> <ul style="list-style-type: none"><li>• Structure and functions:</li><li>• Physical &amp; chemical properties of Nucleic acids, nucleosides &amp; nucleotides, purines &amp; pyrimidines,. Biologically important nucleotides,</li><li>• Double helical model of DNA structure and forces stabilizing DNA double helical structure, A, B and Z – DNA, denaturation and renaturation of DNA.</li></ul> |                                                         | 7                            |
| <b>IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Lipids:</b> <ul style="list-style-type: none"><li>• Structure and functions of Lipids</li><li>• Classification, nomenclature and properties of fatty acids, essential fatty acids.</li><li>• Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.</li></ul>                                                                                                               |                                                         | 6                            |
| <b>V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Enzymes and Enzyme classification:</b> <ul style="list-style-type: none"><li>• Nomenclature and classification of Enzymes, brief introduction to active site.</li><li>• Kinetics of enzyme actions</li><li>• Cofactors, coenzyme, prosthetic groups, holoenzyme and</li></ul>                                                                                                                                            |                                                         | 8                            |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | apoenzyme <ul style="list-style-type: none"> <li>Enzyme inhibition – competitive, Non-competitive &amp; uncompetitive type.</li> </ul>                                                                                                                                                                                                                                                                                                                                             |   |
| <b>VI</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Metabolism:</b> <ul style="list-style-type: none"> <li>Metabolism of carbohydrates- Gluconeogenesis, Glycolysis, TCA, and Glyoxylate cycle</li> <li>Metabolism of fatty acids-oxidation of saturated, unsaturated fatty acids</li> <li>Oxidation of amino acids and urea cycle.</li> </ul>                                                                                                                                                                                      | 9 |
| <b>VII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Vitamins and Hormone:</b> <ul style="list-style-type: none"> <li>Introduction to Vitamins, hormones, Phytohormones and their role</li> <li>Deficiency of vitamins and hormones and related human diseases.</li> </ul>                                                                                                                                                                                                                                                           | 8 |
| <b>VIII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Techniques:</b> <ul style="list-style-type: none"> <li>Chromatography (Column chromatography, Ion- exchange chromatography, Gel- permeation (molecular sieve, chromatography, Affinity chromatography, Paper chromatography, Thin-layer chromatography, Gas chromatography and HPLC)             <ul style="list-style-type: none"> <li>Spectroscopy (UV-Vis)</li> <li>NMR</li> <li>X-ray diffraction</li> <li>Centrifugation</li> <li>Mass spectrometry</li> </ul> </li> </ul> | 8 |
| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>Berg, JM Tymoczko, JL. Gatto, GJ., Stryer, L. (2015). <b>Biochemistry</b>. (8th ed.) W H Freeman and Company New York.</li> <li>Nelson DL. Cox MM. (2017) <b>Lehninger Principles of Biochemistry</b> (7th ed.). W H Freeman New York.</li> <li>Voet, D., &amp; Voet, J. G. (2016). <b>Biochemistry</b> (5th ed.). Hoboken, NJ: J. Wiley &amp; Sons.</li> <li>Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). <b>Harper’s Illustrated Biochemistry</b>.(31<sup>st</sup> edition) McGraw-Hill Education</li> <li>Hofmann A. Clokie S. <b>Wilson and Walker’s Principles and Techniques of Biochemistry and Molecular Biology</b>. (2018) (8<sup>th</sup> edition)Cambridge University Press</li> <li>Boyer RF. (2012) <b>Biochemistry laboratory : modern theory and techniques</b>(2<sup>nd</sup> Edition). Pearson Education, Inc</li> <li>Jain JL. Jain S. Jain N. (2005). <b>Fundamentals of Biochemistry</b>. (6<sup>th</sup> edition). S Chand and Company Ltd.</li> <li>Satyanarayana U. Chakrapani U. (2013). <b>Biochemistry</b>.(4<sup>th</sup> edition). Elsevier and Books and Allied (P) Ltd</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |
| <p style="text-align: center;"><b>Suggested link</b></p> <ul style="list-style-type: none"> <li><a href="https://ocw.mit.edu/courses/findbytopic/#cat=science&amp;subcat=biology&amp;spec=biochemis">https://ocw.mit.edu/courses/findbytopic/#cat=science&amp;subcat=biology&amp;spec=biochemis</a></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |   |

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| <a href="#">try</a> <ul style="list-style-type: none"> <li>• <a href="https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&amp;subcat=spectroscopy">https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&amp;subcat=spectroscopy</a></li> <li>• <a href="https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-4/">https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-4/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecture-videos/lecture-4-enzymes-and-metabolism/">https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecture-videos/lecture-4-enzymes-and-metabolism/</a></li> <li>• <a href="https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-3/">https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-3/</a></li> <li>• <a href="https://nptel.ac.in/courses/104/105/104105076/">https://nptel.ac.in/courses/104/105/104105076/</a></li> <li>• <a href="https://nptel.ac.in/courses/102/106/102106087/">https://nptel.ac.in/courses/102/106/102106087/</a></li> </ul> |
| <b>Suggested Digital platform/Web link</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p align="center"><b>Course prerequisite</b></p> <p>To study this course, student must have passed semester II.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <p align="center"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total Marks: 25</b><br/> 10 marks for Test<br/> 10 marks for presentation along with assignment<br/> 05 marks for Class interactions</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Further Suggestions:</b> None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

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| <b>Programme/Class:</b> Diploma                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Year:</b> Second (2)                                                                                                                                                                                                             | <b>Semester:</b> Third(III) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                     |                             |
| <b>Couse Code:</b> B100302P                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Course Title:</b> Biochemistry Lab                                                                                                                                                                                               |                             |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                     |                             |
| Students will get practical exposure to commonly used biochemical techniques and also they become familiar to use instruments like calorimeter, pHmeter etc.<br>Introduce the primary steps in biomolecules (focus on proteins) purification which includes various methods in isolation and quantitation of proteins.<br>2. Learn how to separate proteins from a heterogenous mixture.<br>3. Learn to apply important chromatographic techniques to purify biomolecules<br>4. Familiarize the working principles of electrophoresis and UV/Vis and fluorescence spectroscopic techniques and application of the knowledge to get basic structural information of proteins |                                                                                                                                                                                                                                     |                             |
| <b>Credits:</b> 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Core Compulsory</b>                                                                                                                                                                                                              |                             |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                               |                             |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                     |                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Topic</b>                                                                                                                                                                                                                        | <b>No. of Lectures</b>      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1. Preparation of normal and molar solutions<br>2. Preparation of buffers.<br>3. To study activity of any enzyme under optimum conditions.<br>4. To study the effect of pH, temperature on the activity of salivary amylase enzyme. | 60                          |

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| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>1. Berg, JM Tymoczko, JL. Gatto, GJ Jr. Stryer, L. (2015). <b>Biochemistry</b>. (8th ed.) W H Freeman and Company New York.</li> <li>2. Nelson DL. Cox MM. (2017) <b>Lehninger Principles of Biochemistry</b> (7th ed.). W H Freeman New York.</li> <li>3. Voet, D., &amp; Voet, J. G. (2016). <b>Biochemistry</b> (5th ed.). Hoboken, NJ: J. Wiley &amp; Sons.</li> <li>4. Rodwell VW. Bender D. Botham KM. Kennelly PJ Weil PA.(2018). <b>Harper's Illustrated Biochemistry</b>.(31<sup>st</sup> edition) McGraw-Hill Education</li> <li>5. Hofmann A. Clokie S. <b>Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology</b>. (2018) (8<sup>th</sup> edition)Cambridge University Press</li> <li>6. Boyer RF. (2012) <b>Biochemistry laboratory : modern theory and techniques</b>(2<sup>nd</sup> Edition). Pearson Education, Inc</li> <li>7. Jain JL. Jain S. Jain N. (2005). <b>Fundamentals of Biochemistry</b>. (6<sup>th</sup> edition). S Chand and Company Ltd.</li> <li>8. Satyanarayana U. Chakrapani U. (2013). <b>Biochemistry</b>.(4<sup>th</sup> edition). Elsevier and Books and Allied (P) Ltd</li> <li>9. R.K. <b>Practical Biochemistry</b> – David Plummer. <b>Pub:</b> Tata McGraw Hill</li> <li>10. Roskam's J. Rodgers L.(2002). <b>Lab Ref: A Handbook of Recipes, Reagents, and other reference tools for use at the Bench</b>. Cold Spring Harbor Laboratory Press. USA.</li> <li>11. Barker K(2004). <b>At the Bench: A laboratory Navigator</b>. Cold Spring Harbor Laboratory Press. USA</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| <p style="text-align: center;"><b>Course prerequisite</b></p> <p>To study this course, student must have passed semester II.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| <p style="text-align: center;"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total marks: 25</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |

10 marks for Test  
 10 marks for presentation along with assignment  
 05 marks for Class interactions

**Further Suggestions:** None

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| <b>Programme/Class:</b> Diploma                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Year:</b> Second (2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Semester:</b> Fourth (IV) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              |
| <b>Couse Code:</b> B100401T                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Course Title:</b> Microbiology and Immunology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                              |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              |
| On the successful completion of the course, student will be able to: <ul style="list-style-type: none"><li>• the pioneers in microbiology and their contributions</li><li>• understand the physical and chemical method of sterilization</li><li>• analyze the media composition and grow the desired microbe.</li><li>• understand the methods of cultivation of microorganisms</li><li>• understand different staining methods</li><li>• understand and differentiate the different types of microbes.</li><li>• understand the principles of immunology</li><li>• learn about structural features of components of immune system as well as their function and development of immune system and mechanisms by which our body elicits immune response.</li><li>• predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.</li><li>• understand different tools and techniques of immunology</li><li>• understand the biology of different vaccines against infectious agents</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              |
| <b>Credits:</b> 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P:</b> 4-0-0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                              |
| <b>Unit</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>No. of Lectures</b>       |
| <b>I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Diversity and classification of microbes:</b> <ul style="list-style-type: none"><li>• Fundamentals, History and Evolution of Microbiology.</li><li>• Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.</li><li>• Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells,</li><li>• Morphology and cell structure of major groups of microorganisms - Viruses, Bacteria, Algae, Fungi, and Protozoa.</li></ul> | 7                            |
| <b>II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Microbial growth:</b> <ul style="list-style-type: none"><li>• Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.</li><li>• Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways</li></ul>                                                                                                                                                                                                                                               | 8                            |

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|             | <ul style="list-style-type: none"> <li>Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                         |   |
| <b>III</b>  | <b>Pathogen contamination and infectious diseases:</b> <ul style="list-style-type: none"> <li>Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.</li> <li>Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.</li> <li>Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.</li> <li>Bacterial diseases of human- Tuberculosis, Tetanus, Typhoid, Cholera</li> <li>Viral diseases of human-Hepatitis B andC, AIDS</li> </ul> | 8 |
| <b>IV</b>   | <b>Sterilization, cultivation and staining:</b> <ul style="list-style-type: none"> <li>Principals and applications of different methods of sterilization</li> <li>Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms</li> <li>Methods of isolation, Purification and preservation.</li> <li>Principals of staining and types of staining</li> </ul>                                                                                                                                                                                               | 7 |
| <b>V</b>    | <b>Introduction to immune system:</b> <ul style="list-style-type: none"> <li>Introduction to Immunology, Components of mammalian immune system (cell and organs), Innate and Adaptive immunity</li> <li>Humoral and cell mediated immune response, Clonal selection theory</li> <li>An overview of primary and secondary immune responses</li> </ul>                                                                                                                                                                                                                                    | 8 |
| <b>VI</b>   | <b>Antigen and Antibody structure and diversity:</b> <ul style="list-style-type: none"> <li>Antigen, epitopes and Adjuvants</li> <li>Structure and isotypes of Immunoglobulins allotypes and idiotypes</li> <li>B- and T-cell receptors</li> <li>B and T cell maturation</li> <li>Antibody diversity generation, somatic gene rearrangements during B-lymphocyte differentiation, allelic exclusion, affinity maturation, class switching , somatic hypermutation</li> </ul>                                                                                                            | 8 |
| <b>VII</b>  | <b>MHC, antigen processing and presentation:</b> <ul style="list-style-type: none"> <li>Major Histocompatibility complexes – class I &amp; class II MHC antigens, antigen processing.</li> <li>Antigen processing and presentation</li> <li>Autoimmune diseases, Immunodeficiency-AIDS and SCID.</li> </ul>                                                                                                                                                                                                                                                                             | 7 |
| <b>VIII</b> | <b>Immunological Techniques and Vaccines:</b> <ul style="list-style-type: none"> <li>Introduction to immunodiagnostics – Precipitation, Agglutination, RIA, ELISA and Immunofluorescence.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                    | 7 |

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| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>1. Pelczar M J, Reid R D, and Chan EC. (2001). <b>Microbiology</b> (5th ed.). New York: McGraw-Hill.</li> <li>2. Willey J M, Sherwood L, Woolverton C J, Prescott L M, and Willey J M. (2011). <b>Prescott's Microbiology</b>. New York: McGraw-Hill.</li> <li>3. Mattha, W, Berg C Y, and Black JG. (2005). <b>Microbiology, Principles and Explorations</b>. Boston, MA: John Wiley &amp; Sons.</li> <li>4. Cappuccino J G, and Welsh, C. (2016). <b>Microbiology: a Laboratory Manual</b>. Benjamin-Cummings Publishing Company.</li> <li>5. Collins C H, Lyne PM, Grange J M, and Falkinham III J. (2004). <b>Collins and Lyne's Microbiological Methods</b> (8th ed.). Arnolds.</li> <li>6. Levinson WE. (2020). <b>Review of Medical Microbiology and Immunology</b> (16<sup>th</sup> edition). McGraw Hill Education.</li> <li>7. Ananthanarayana R, Panicker CKJ(2020). <b>Ananthanarayana and Panicker's Textbook of Microbiology</b>(11<sup>th</sup> edition) Universities Press (India) Pvt. Ltd</li> <li>8. Punt J, Stranford S, Jones P., Owen JA, (2018). <b>Kuby Immunology</b>.(8<sup>th</sup> edition) New York: W.H. Freeman.</li> <li>9. Delves P J, Martin SJ, Burton DR, and Roitt IM. (2017). <b>Roitt's Essential Immunology</b>.(13<sup>th</sup> edition). Wiley- Blackwell.</li> <li>10. Murphy K, and Weaver C, (2016). <b>Janeway's Immunobiology</b>. (9<sup>th</sup> edition) New York: Garland Science.</li> <li>11. Abbas AK, Lichtman AHH, Pillai S.(2017) <b>Cellular and Molecular Immunology</b> (9<sup>th</sup> edition)</li> <li>12. Paul W E. (2012). <b>Fundamental Immunology</b>. New York: Raven Press.</li> <li>13. Parham, P. (2005). <b>The Immune System</b>. New York: Garland Science.</li> <li>14. Mohanty SK, Leela KS.(2014) <b>Textbook of Immunology</b>. (2<sup>nd</sup> Edition). Jaypee Brothers Medical Publishers Pvt Ltd.</li> <li>15. Hay FC, Westwood OMR.(2008). <b>Practical Immunology</b>.(4<sup>th</sup> Edition). Wiley Blackwell.</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                                                                   |  |
| <p style="text-align: center;"><b>Suggested link</b></p> <ul style="list-style-type: none"> <li>• <a href="https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=microbiology">https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=microbiology</a></li> <li>• <a href="https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&amp;subcat=immunology">https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&amp;subcat=immunology</a></li> <li>• <a href="https://nptel.ac.in/courses/102/103/102103038/">https://nptel.ac.in/courses/102/103/102103038/</a></li> <li>• <a href="https://nptel.ac.in/courses/102/105/102105083/">https://nptel.ac.in/courses/102/105/102105083/</a></li> <li>• <a href="https://nptel.ac.in/courses/102/103/102103015/">https://nptel.ac.in/courses/102/103/102103015/</a></li> <li>• <a href="https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf">https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf</a></li> <li>• <a href="https://nptel.ac.in/content/storage2/courses/102103015/module1/lec1/1.html">https://nptel.ac.in/content/storage2/courses/102103015/module1/lec1/1.html</a></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                   |  |
| <p style="text-align: center;"><b>Suggested Digital platform/Web link</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                   |  |
| <p style="text-align: center;"><b>Course prerequisite</b></p> <p>To study this course, student must have passed semester III.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                   |  |
| <p style="text-align: center;"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p>10 marks for Test</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                   |  |

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|-------------------------------------------------|
| 10 marks for presentation along with assignment |
| 05 marks for Class interactions                 |
| <b>Further Suggestions:</b> None                |

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| <b>Programme/Class:</b> Diploma                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Year:</b> Second (2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Semester:</b> Fourth (IV) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |
| <b>Couse Code:</b> B100402 P                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Course Title:</b> Microbiology and Immunology Lab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |
| After completion of this course , students will be able to: <ul style="list-style-type: none"><li>• Understand methods of cleaning and sterilization of plasticwares and glasswares.</li><li>• understand and perform pure culture techniques which includes, pour plate and spread plate .</li><li>• understand the preparation and use of differential, selective and special media.</li><li>• understand and identify the morphology of cells of the immune system.</li><li>• understand the basic concepts of blood grouping.</li><li>• understand antigen antibody interactions and thus quantitate the presence of antigen and or antibodies in biological samples.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |
| <b>Credits:</b> 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                              |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                              |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>No. of Lectures</b>       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1. Safety measures in microbiology laboratory<br>2. Study of instruments: Compound microscope, Autoclave, Hot air oven, PH meter, and Laminar airflow<br>3. Introduction to different sterilization techniques<br>4. Isolation of bacteria & their biochemical characterization.<br>5. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.<br>6. Preparation of media and sterilization,<br>7. Methods of isolation of bacteria from different sources.<br>8. Determination of bacterial cell size by micrometry.<br>9. Enumeration of microorganism - total & viable count.<br>10. Differential leucocytes count<br>11. Total leucocytes count<br>12. Total RBC count<br>13. Haemagglutination assay<br>14. Separation of serum from blood<br>15. Double immunodiffusion test using specific antibody and antigen.<br>16. ELISA demonstration | 60                           |
| <b>Suggested Reading</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                              |

1. Pelczar M J, Reid R D, and Chan EC. (2001). **Microbiology** (5th ed.). New York: McGraw-Hill.
2. Willey J M, Sherwood L, Woolverton C J, Prescott L M, and Willey J M. (2011). **Prescott's Microbiology**. New York: McGraw-Hill.
3. Mattha, W, Berg C Y, and Black JG. (2005). **Microbiology, Principles and Explorations**. Boston, MA: John Wiley & Sons.
4. Cappuccino J G, and Welsh, C. (2016). **Microbiology: a Laboratory Manual**. Benjamin-Cummings Publishing Company.
5. Collins C H, Lyne PM, Grange J M, and Falkinham III J. (2004). **Collins and Lyne's Microbiological Methods** (8th ed.). Arnolds.
6. Levinson WE. (2020). **Review of Medical Microbiology and Immunology** (16<sup>th</sup> edition). McGraw Hill Education.
7. Ananthanarayana R, Panicker CKJ(2020). **Ananthanarayana and Panicker's Textbook of Microbiology**(11<sup>th</sup> edition) Universities Press (India) Pvt. Ltd
8. Punt J, Stranford S, Jones P., Owen JA, (2018). **Kuby Immunology**.(8<sup>th</sup> edition) New York: W.H. Freeman.
9. Delves P J, Martin SJ, Burton DR, and Roitt IM. (2017). **Roitt's Essential Immunology**.(13<sup>th</sup> edition). Wiley- Blackwell.
10. Murphy K, and Weaver C, (2016). **Janeway's Immunobiology**. (9<sup>th</sup> edition) New York: Garland Science

**Course books published in Hindi must be prescribed by the University/College**

#### **Course prerequisite**

To study this course, student must have passed semester III.

#### **Suggested Continuous Internal Evaluation (CIE) methods**

**Total marks: 25**

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

**Further Suggestions: None**

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| <b>Programme/Class:</b> Degree                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Year:</b> Third (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Semester:</b> Fifth (V) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                            |
| <b>Couse Code:</b> B100501T                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Course Title:</b> Biostatistics and Bioinformatics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                            |
| After completion of the course, students will be able to - <ul style="list-style-type: none"><li>• learn the need of statistical approach, identify the different axiomatic approach.</li><li>• learn to study the variability of observation.</li><li>• know effective use of Office package –word, excel, ppt and publisher etc</li><li>• understand simple calculation usinf excel</li><li>• understand the basic theories and practicals of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.</li><li>• critically analyse and interpret results of their studies with the help of bioinfomational and biostatistical tools.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                            |
| <b>Credits:</b> 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                            |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                            |
| <b>Unit</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>No. of Lectures</b>     |
| <b>I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>History and introduction to Bioinformatics:</b> <ul style="list-style-type: none"><li>• Introduction and applications of bioinformatics</li><li>• Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.</li></ul>                                                                                                                                                          | 7                          |
| <b>II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Databases, Data generation, Data storage and retrieval:</b> <ul style="list-style-type: none"><li>• General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL), Protein databases (Primary, Composite, and Secondary).</li><li>• Specialized Genome databases: (SGD, TIGR, and ACeDB).</li><li>• Structure databases (CATH, SCOP, and PDBsum)</li><li>• File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).</li><li>• Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.</li></ul> | 8                          |
| <b>III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Sequence and Phylogeny analysis:</b> <ul style="list-style-type: none"><li>• Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).</li><li>• Introduction to BLAST, using it on the web, Interpreting results, Phylogenetic Analysis.</li><li>• PCR primer designing etc.</li></ul>                                                                                   | 8                          |
| <b>IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Searching Databases:</b> <ul style="list-style-type: none"><li>• SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission.</li><li>• Genome Annotation: Pattern and repeat finding, Gene identification tools.</li></ul>                                                                                                                                                                                                                                                                                                            | 7                          |

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| <b>V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Types and Collection of data:</b> <ul style="list-style-type: none"> <li>Primary and Secondary data, Classification and Graphical representation of Statistical data.</li> <li>Measures of central tendency and Dispersion.</li> <li>Measures of Skewness and Kurtosis.</li> </ul>                                                          | 7 |
| <b>VI</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Probability:</b> <ul style="list-style-type: none"> <li>Definition of probability, Theorems on total and compound probability</li> <li>Elementary ideas of Binomial, Poisson and Normal distributions.</li> </ul>                                                                                                                           | 8 |
| <b>VII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Sampling:</b> <ul style="list-style-type: none"> <li>Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test.</li> <li>Problems on test of significance, t-test, chi-square test</li> <li>for goodness of fit and analysis of variance (ANOVA)</li> </ul> | 8 |
| <b>VIII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Correlation and Regression:</b> <ul style="list-style-type: none"> <li>Types, Karl-Pearson's correlation, Spearman's Rank correlation, Regression equation and fitting</li> <li>Main features of regression analysis-simple and multiple regression analysis</li> <li>Differences between correlation and regression analysis</li> </ul>    | 7 |
| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>Lesk, A. M. (2002). <b>Introduction to Bioinformatics</b>. Oxford: Oxford University Press.</li> <li>Mount, D. W. (2001). <b>Bioinformatics: Sequence and Genome Analysis</b>. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.</li> <li>Baxeavanis, A. D., &amp; Ouellette, B. F. (2001). <b>Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins</b>. New York: Wiley-Interscience.</li> <li>Pevsner, J. (2015). <b>Bioinformatics and Functional Genomics</b>. Hoboken, NJ.: Wiley-Blackwell.</li> <li>Bourne, P. E., &amp; Gu, J. (2009). <b>Structural Bioinformatics</b>. Hoboken, NJ: Wiley-Liss.</li> <li>Sharma V. Munjal A. Shanker A.(2018). <b>A Textbook of Bioinformatics</b>.(2<sup>nd</sup> Edition). Rastogi Publication.</li> <li>Choudhuri S. (2014) <b>Bioinformatics for beginners</b>. (1<sup>st</sup> edition) Elsevier.</li> <li>Harisha S. (2019) <b>Fundamentals of Bioinformatics</b>. Dreamtech Press</li> <li>Rastogi SC. Mendiratta N. Rastogi P. (2013). <b>Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery</b>. (4<sup>th</sup> edition). Prentice Hall India Learning Private Limited</li> <li>Ghosh Z. Mallick B. (2008). <b>Bioinformatics: Principles and Applications</b>. OUP India</li> <li>Rosner, B. (2000). <b>Fundamentals of Biostatistics</b>. Boston, MA: Duxbury Press.</li> <li>Daniel, W. W. (1987). <b>Biostatistics, a Foundation for Analysis in the Health Sciences</b>. New York: Wiley</li> <li>Mariappan P. (2013) <b>Biostatistics</b>. Pearson</li> <li>Rastogi VB.(2015). <b>Biostatistics</b> (3<sup>rd</sup> Edition). MedTec</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                                                                                                                                                                                                |   |
| <b>Suggested link</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                |   |

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| <ul style="list-style-type: none"> <li>• <a href="https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-bioinformatics-and-proteomics-january-iap-2005/lecture-notes/">https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-bioinformatics-and-proteomics-january-iap-2005/lecture-notes/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/">https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/lecture-slides/">https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/lecture-slides/</a></li> <li>• <a href="https://ocw.mit.edu/courses/mathematics/18-650-statistics-for-applications-fall-2016/">https://ocw.mit.edu/courses/mathematics/18-650-statistics-for-applications-fall-2016/</a></li> <li>• <a href="https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/">https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/</a></li> <li>• <a href="https://ocw.mit.edu/courses/mathematics/18-443-statistics-for-applications-fall-2003/lecture-notes/">https://ocw.mit.edu/courses/mathematics/18-443-statistics-for-applications-fall-2003/lecture-notes/</a></li> </ul> |
| <b>Suggested Digital platform/Web link</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p align="center"><b>Course prerequisite</b></p> <p>To study this course, student must have passed semester IV.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p align="center"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total marks:</b> 25<br/> 10 marks for Test<br/> 10 marks for presentation along with assignment<br/> 05 marks for Class interactions</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Further Suggestions:</b> None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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| <b>Programme/Class:</b> Degree                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Year:</b> Third (3)                                                                                                                                                                                                                                           | <b>Semester:</b> Fifth (V) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                  |                            |
| <b>Couse Code:</b> B100502T                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Course Title:</b> Animal and Plant Biotechnology                                                                                                                                                                                                              |                            |
| <b>Course Outcomes (COs)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                  |                            |
| After completion of this course, students will be able to- <ul style="list-style-type: none"><li>• understand the principles, practices and application of animal biotechnology in Transgenesis, Tissue Engineering, and biopharmaceuticals.</li><li>• understand the principles, practices and applications of plant biotechnology, transgenic plant generation, plant tissue culture, plant genomics, and genetic transformation.</li><li>• understand applications of stem cells and tissues engineering.</li><li>• learn different gene delivery methods to deliver foreign gene in plants and animals</li><li>• know about different products of transgenic animals, plants and microbes.</li></ul> |                                                                                                                                                                                                                                                                  |                            |
| <b>Credits:</b> 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Core Compulsory</b>                                                                                                                                                                                                                                           |                            |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                            |                            |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                  |                            |
| <b>Unit</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Topic</b>                                                                                                                                                                                                                                                     | <b>No. of Lectures</b>     |
| <b>I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Transgenesis:</b> <ul style="list-style-type: none"><li>• Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.</li><li>• Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis,</li></ul> | 7                          |

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|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|             | Trypanosomiasis, Theileriosis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |
| <b>II</b>   | <b>Gene delivery methods for animals :</b> <ul style="list-style-type: none"> <li>• Viral vectors</li> <li>• Vector less or direct DNA transfer, particle bombardment, electroporation, microinjection &amp; chemical methods, creation of animal models of human diseases.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                         | 8 |
| <b>III</b>  | <b>Animal propagation:</b> <ul style="list-style-type: none"> <li>• Artificial insemination, animal Clones.</li> <li>• Conservation Biology – embryo transfer techniques.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 6 |
| <b>IV</b>   | <b>Genetic modification in Medicine:</b> <ul style="list-style-type: none"> <li>• Gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering,</li> <li>• Human genetic engineering, problems &amp; ethics</li> <li>• Introduction to Stem Cell Technology and its applications</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                             | 8 |
| <b>V</b>    | <b>Introduction, Cryo and organogenic differentiation:</b> <ul style="list-style-type: none"> <li>• Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture.</li> <li>• Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropopagation.</li> <li>• Protoplast isolation and fusion, methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations.</li> <li>• Somaclonal variation nomenclature, methods, applications basis and disadvantages</li> </ul> | 7 |
| <b>VI</b>   | <b>In vitro haploid production Androgenic methods:</b> <ul style="list-style-type: none"> <li>• Anther culture, Microspore culture androgenesis</li> <li>• Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis</li> <li>• Chromosome elimination techniques for production of haploids in cereals.</li> </ul>                                                                                                                                                                                                                                                                                                            | 8 |
| <b>VII</b>  | <b>Plant Growth Promoting bacteria:</b> <ul style="list-style-type: none"> <li>• Nitrogen fixation,</li> <li>• Nitrogenase, Hydrogenase, Nodulation</li> <li>• Biocontrol of pathogens</li> <li>• Growth promotion by free-living bacteria.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 8 |
| <b>VIII</b> | <b>Transgenesis:</b> <ul style="list-style-type: none"> <li>• Plant transformation technologies</li> <li>• <i>Agrobacterium tumifaciens</i> infection, basis of tumor formation, features of Ti &amp; Ri plasmids,</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 8 |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>mechanisms of DNA transfer, role of virulence genes, use of Ti plasmid as vector, binary vectors</p> <ul style="list-style-type: none"> <li>• Application of plant transformation for productivity and performance: Herbicides resistance, insect resistance, Bt genes, non-Bt like protease inhibitors, virus resistance, long shelf life of fruits and flowers</li> </ul> |  |
| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>1. Razdan, M. K. (2003). <b>Introduction to Plant Tissue Culture</b>. Enfield, NH: Science</li> <li>2. Chawla, H. S. (2000). <b>Introduction to Plant Biotechnology</b>. Enfield, NH: Science.</li> <li>3. Smith R(2012). <b>Plant Tissue Culture</b> (3<sup>rd</sup> Edition) Academic Press.</li> <li>4. Slater, A., Scott, N. W., &amp; Fowler, M. R. (2008). <b>Plant Biotechnology: an Introduction to Genetic Engineering</b>. Oxford: Oxford University Press.</li> <li>5. Buchanan, B. B., Gruissem, W., &amp; Jones, R. L. (2015). <b>Biochemistry &amp; Molecular Biology of Plants</b>. Chichester, West Sussex: John Wiley &amp; Sons.</li> <li>6. Umesha, S. (2013). <b>Plant Biotechnology</b>. The Energy and Resources.</li> <li>7. Glick, B. R., &amp; Pasternak, J. J. (2010). <b>Molecular Biotechnology: Principles and Applications of Recombinant DNA</b>. Washington, D.C.: ASM Press.</li> <li>8. Brown, T. A. (2006). <b>Gene Cloning and DNA Analysis: an Introduction</b>. Oxford: Blackwell Pub.</li> <li>9. Primrose, S. B., &amp; Twyman, R. M. (2006). <b>Principles of Gene Manipulation and Genomics</b>. Malden, MA: Blackwell Pub.</li> <li>10. Slater, A., Scott, N. W., &amp; Fowler, M. R. (2003). <b>Plant Biotechnology: The Genetic Manipulation of Plants</b>. Oxford: Oxford University Press.</li> <li>11. Levine, M. M. (2004). <b>New Generation Vaccines</b>. New York: M. Dekker.</li> <li>12. Pörtner, R. (2007). <b>Animal Cell Biotechnology: Methods and Protocols</b>. Totowa, NJ: Humana Press</li> <li>13. Singh B. Gautam SK (2013). <b>Textbook of animal biotechnology</b>. The Energy and Resources Institute, TERI</li> <li>14. Gupta PK.(2018) <b>Animal Biotechnology</b>. Rastogi Publications</li> <li>15. Singh BD. (2015). <b>Plant Biotechnology</b> (3<sup>rd</sup> edition). Kalyani Publishers</li> <li>16. Chawla HS. (2020) <b>Introduction to Plant Biotechnology</b>(3<sup>rd</sup> edition) OXFORD &amp; IBH Publishing</li> <li>17. Satyanarayana U (2020). <b>Biotechnology</b>. Books and Allied (P) Ltd</li> <li>18. Singh BD. (2015). <b>Biotechnology: Expanding Horizons</b> (4<sup>th</sup> edition). Kalyani Publishers</li> <li>19. Dubey RC. (2014) <b>A Textbook of Biotechnology</b> (5<sup>th</sup> edition) S Chand and Company Ltd.</li> <li>20. सिंह बी डी(2017) <b>बायोटेक्नोलोजी</b> Kalyani Publishers</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                                                                                                                                                                                                                                |  |
| <p style="text-align: center;"><b>Suggested link</b></p> <ul style="list-style-type: none"> <li>• <a href="https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=stemcells">https://ocw.mit.edu/courses/find-by-topic/#cat=science&amp;subcat=biology&amp;spec=stemcells</a></li> <li>• <a href="https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/lecture-notes/lecture13.pdf">https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/lecture-notes/lecture13.pdf</a></li> <li>• <a href="https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/lecture-notes/">https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-biological-engineering-fall-2007/lecture-notes/</a></li> <li>• <a href="https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/">https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-and-practice-of-tissue-engineering-fall-2004/</a></li> <li>• <a href="https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-">https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-in-</a></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                |  |

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| <a href="http://biological-engineering-fall-2007/labs/mod1_3/">biological-engineering-fall-2007/labs/mod1_3/</a>                                                                                   |
| <b>Suggested Digital platform/Web link</b>                                                                                                                                                         |
| <b>Course prerequisite</b><br>To study this course, student must have passed semester V.                                                                                                           |
| <b>Suggested Continuous Internal Evaluation (CIE) methods</b><br><b>Total marks: 25</b><br>10 marks for Test<br>10 marks for presentation along with assignment<br>05 marks for Class interactions |
| <b>Further Suggestions:</b> None                                                                                                                                                                   |

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| <b>Programme/Class:</b> Degree                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Year:</b> Third (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Semester:</b> Fifth (V) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                            |
| <b>Couse Code:</b> B100503P                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Course Title:</b> Bioinformatics, Biostatistics<br>Tissue culture Lab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                            |
| <b>Course Outcomes (COs)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                            |
| Students should be able to - <ul style="list-style-type: none"><li>• apply basic bioinformatics tools for the studies and research in other areas of their biotechnology and microbiology programs, such as finding</li><li>• gene/protein homologs, designing primers, identifying mutations, etc.</li><li>• do cleaning, sterilization of laboratory, plastic and glasswares.</li><li>• prepare different types of culture media for animal and plant cell culture</li><li>• understand and solve the problems in the area of animal and plant Biotechnology.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                            |
| <b>Credits:</b> 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                            |
| <b>Maximum Marks:</b> 100 (75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                            |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>No. of Lectures</b>     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <ol style="list-style-type: none"><li>1. An introduction to Computers, MS-Word, MS Excel, MS Power Point.</li><li>2. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.</li><li>3. Similarity searches using tools like BLAST and interpretation of results.</li><li>4. Multiple sequence alignment using ClustalW and interpretation of results.</li><li>5. Use of gene prediction methods (GRAIL, Genscan, Glimmer).</li><li>6. Use of various primer designing and restriction site prediction tools.</li><li>7. Use of different protein structure prediction databases (PDB, SCOP, CATH etc.).</li><li>8. Exercise to data entry, edit, copy , move etc. using MS EXCEL spreadsheet</li></ol> | 60                         |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <ol style="list-style-type: none"> <li>9. Computations analysis of biological data by Mean, Median, Mode, S.D., Correlation, regression Analysis, Chi square test, Student test, ANOVA</li> <li>10. Designing of bar diagram, pi chart, histogram, scatter plots, in EXCEL for presentation of data.</li> <li>11. Measure of skewness and kurtosis</li> <li>12. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization</li> <li>13. Sources of contamination and decontamination measures.</li> <li>14. Preparation of Hanks Balanced salt solution</li> <li>15. Preparation of Minimal Essential Growth medium</li> <li>16. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.</li> <li>17. Preparation of complex nutrient medium (Murashige &amp; Skoog's medium)</li> <li>18. To selection, Prune, sterilize and prepare an explant for culture.</li> <li>19. Significance of growth hormones in culture medium.</li> <li>20. To demonstrate various steps of Micropropagation.</li> </ol> |  |
| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>1. Lesk, A. M. (2002). <b>Introduction to Bioinformatics</b>. Oxford: Oxford University Press.</li> <li>2. Mount, D. W. (2001). <b>Bioinformatics: Sequence and Genome Analysis</b>. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.</li> <li>3. Baxevanis, A. D., &amp; Ouellette, B. F. (2001). <b>Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins</b>. New York: Wiley-Interscience.</li> <li>4. Pevsner, J. (2015). <b>Bioinformatics and Functional Genomics</b>. Hoboken, NJ.: Wiley-Blackwell.</li> <li>5. Bourne, P. E., &amp; Gu, J. (2009). <b>Structural Bioinformatics</b>. Hoboken, NJ: Wiley-Liss.</li> <li>6. Sharma V. Munjal A. Shanker A.(2018). <b>A Textbook of Bioinformatics</b>.(2<sup>nd</sup> Edition). Rastogi Publication.</li> <li>7. Choudhuri S. (2014) <b>Bioinformatics for beginners</b>. (1<sup>st</sup> edition) Elsevier.</li> <li>8. Harisha S. (2019) <b>Fundamentals of Bioinformatics</b>. Dreamtech Press</li> <li>9. Rastogi SC. Mendiratta N. Rastogi P. (2013). <b>Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery</b>. (4<sup>th</sup> edition). Prentice Hall India Learning Private Limited</li> <li>10. Ghosh Z. Mallick B. (2008). <b>Bioinformatics: Principles and Applications</b>. OUP India</li> <li>11. Rosner, B. (2000). <b>Fundamentals of Biostatistics</b>. Boston, MA: Duxbury Press.</li> <li>12. Daniel, W. W. (1987). <b>Biostatistics, a Foundation for Analysis in the Health Sciences</b>. New York: Wiley</li> <li>13. Mariappan P. (2013) <b>Biostatistics</b>. Pearson</li> <li>14. Rastogi VB.(2015). <b>Biostatistics</b> (3<sup>rd</sup> Edition). MedTec</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
| <p style="text-align: center;"><b>Course prerequisite</b></p> <p>To study this course, student must have passed semester IV.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
| <p style="text-align: center;"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total marks: 25</b><br/> 10 marks for Test<br/> 10 marks for presentation along with assignment</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |

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| 05 marks for Class interactions  |
| <b>Further Suggestions:</b> None |

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| <b>Programme/Class:</b> Degree                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Year:</b> Third (3)                                                                                                                                                                                                                                                                                                                                                                                               | <b>Semester:</b> Sixth (VI) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Couse Code:</b> B100601T                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Course Title:</b> Industrial and Environmental Biotechnology                                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
| After successful completion of the course, student will be able to: <ul style="list-style-type: none"><li>• understand the problems in isolation, strain improvement and growth of microorganisms in industrial processes.</li><li>• isolate and improve the industrially important microorganisms.</li><li>• understand design and types of fermenters and operation of fermenters.</li><li>• learn fundamentals of Environmental Biotechnology</li><li>• understand the importance of clean (pollution free) environment</li><li>• understand biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling.</li><li>• understand the regulation of bioethics and policies of IPR and entrepreneurship.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Credits:</b> 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Elective</b>                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                |                             |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Unit</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                         | <b>No. of Lectures</b>      |
| <b>I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Introduction of Industrial microbiology and Bioprocess technology:</b> <ul style="list-style-type: none"><li>• History-Introduction, scope and relation with other sciences.</li><li>• Screening for new metabolites: primary and secondary products.</li><li>• Strain development through selection, mutations and recombination, and other recent methods</li></ul>                                             | 7                           |
| <b>II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Bioprocess technology:</b> <ul style="list-style-type: none"><li>• Introduction to bioprocess technology.</li><li>• Design and working of a typical bioreactor</li><li>• Range of bioprocess technology and its chronological development.</li><li>• Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.</li></ul> | 9                           |
| <b>III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Production of alcohols, antibiotic and enzymes:</b> <ul style="list-style-type: none"><li>• Production of alcohols (Ethanol) and organic acids (citric and acetic).</li><li>• Production of biologically active compounds:</li></ul>                                                                                                                                                                              | 9                           |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | antibiotics (penicillin) and enzymes (amylase, protease). <ul style="list-style-type: none"> <li>• Production of microbial food and single cell proteins</li> <li>• Bioreactor for immobilized cells/enzyme system</li> <li>• Biosensors and their applications</li> </ul>                                                                                                                                              |   |
| <b>IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Environment and pollution:</b> <ul style="list-style-type: none"> <li>• Physico-chemical and biological characteristics of environment.</li> <li>• Water, soil and air as a component of environment.</li> <li>• Pollutants: Nature, origin, source, monitoring and their impacts.</li> <li>• Air, Water and Noise pollution</li> <li>• Conventional fuels and their environmental impact</li> </ul>                 | 8 |
| <b>V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Bioremediation:</b> <ul style="list-style-type: none"> <li>• Bioremediation of soil &amp; water contaminated with oil spills, heavy metals and detergents.</li> <li>• Degradation of lignin and cellulose using microbes. Phyto-remediation.</li> <li>• Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons and petroleum products.</li> </ul> | 8 |
| <b>VI</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Sewage treatment and biofertilizers:</b> <ul style="list-style-type: none"> <li>• Treatment of municipal waste and Industrial effluents.</li> <li>• Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil.</li> <li>• Algal and fungal biofertilizers (VAM)</li> </ul>                                                                                                | 7 |
| <b>VIII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Bioleaching and genetically modified organisms:</b> <ul style="list-style-type: none"> <li>• Enrichment of ores by microorganisms (Gold, Copper and Uranium).</li> <li>• Environmental significance of genetically modified microbes, plants and animals.</li> </ul>                                                                                                                                                 | 6 |
| <b>VIII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Bioethics, IPR, Entrepreneurship:</b> <ul style="list-style-type: none"> <li>• Importance of Bioethics, IPR and entrepreneurship</li> <li>• Introduction to Intellectual Property Rights (IPR)- World Intellectual properties, Indian Intellectual properties</li> <li>• Entrepreneurship in India</li> </ul>                                                                                                        | 6 |
| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>1. Glazier AN and Nikaido H (2007). Microbial Biotechnology – Fundamental &amp; Applied Microbiology – Second Edition. Cambridge University Press.</li> <li>2. Casida LE (2019) <b>Industrial Microbiology</b>. Second Edition, New Age International Publisher.</li> <li>3. Stanbury P F and Whitaker, A. (2010). <b>Principles of Fermentation Technology</b>. Oxford: Pergamon Press</li> <li>4. Shuler M L and Kargi F. (2002). <b>Bioprocess Engineering: Basic Concepts</b>. Upper Saddle River, NJ: Prentice Hall.</li> <li>5. Crueger W and Crueger A (2002) Cruegers Biotechnology: <b>A Textbook of Industrial Microbiology</b>. Third Edition, Panima Publishing Corp., New Delhi.</li> <li>6. Blanch H W and Clark D S. (1997). <b>Biochemical Engineering</b>. New York: M.</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                         |   |

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| <p>Dekker.</p> <ol style="list-style-type: none"> <li>Bailey J E and Ollis D F. (1986). <b>Biochemical Engineering Fundamentals</b>. New York: McGraw-Hill.</li> <li>Richard HB, Julian ED, Arnold LD. (2010) <b>Manual of Industrial Microbiology and Biotechnology</b>, 3<sup>rd</sup> Edition</li> <li>Thakur IS. (2011) <b>Environmental Biotechnology basic concepts and applications</b>. I. K. International Publishing House Pvt. Limited</li> <li>Evans GM and J. C. Furlong (2003). <b>Environmental Biotechnology: Theory and Applications</b>. Wiley Publishers.</li> <li>Ritmann R and McCarty P L (2000). <b>Environmental Biotechnology: Principle &amp; Applications</b>. 2nd Ed., McGraw Hill Science.</li> <li>Scragg A., (2005) <b>Environmental Biotechnology</b>. Pearson Education Limited.</li> <li>Srinivas TR (2008). <b>Environmental Biotechnology</b>. New Age International Pvt. Ltd.</li> <li>Chapman JL .<b>Ecology: Principal &amp; Application</b>. Cambridge Univ. Press.</li> <li>Odum E and Barret G. (2004) <b>Fundamentals of Ecology</b>. Nataraj Publication.</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p>                                                                                                                                                                                                                                                                                                  |  |
| <p style="text-align: center;"><b>Suggested link</b></p> <ul style="list-style-type: none"> <li><a href="https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-34-waste-containment-and-remediation-technology-spring-2004/lecture-notes/">https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-34-waste-containment-and-remediation-technology-spring-2004/lecture-notes/</a></li> <li><a href="https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-the-earth-system-fall-2009/">https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-the-earth-system-fall-2009/</a></li> <li><a href="https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-the-earth-system-fall-2009/lecture-notes/MIT1_018JF09_Lec07.pdf">https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-018j-ecology-i-the-earth-system-fall-2009/lecture-notes/MIT1_018JF09_Lec07.pdf</a></li> <li><a href="https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89-environmental-microbiology-fall-2004/">https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89-environmental-microbiology-fall-2004/</a></li> <li><a href="https://ocw.mit.edu/high-school/biology/exam-prep/cellular-energetics/fermentation-cellular-respiration/fermentation/">https://ocw.mit.edu/high-school/biology/exam-prep/cellular-energetics/fermentation-cellular-respiration/fermentation/</a></li> </ul> |  |
| <p style="text-align: center;"><b>Suggested Digital platform/Web link</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| <p style="text-align: center;"><b>Course prerequisite</b></p> <p>To study this course, a student must have passed semester V.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| <p style="text-align: center;"><b>Suggested Continuous Internal Evaluation (CIE) methods</b></p> <p><b>Total marks:</b> 25<br/> 10 marks for Test<br/> 10 marks for presentation along with assignment<br/> 05 marks for Class interactions</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| <p><b>Further Suggestions:</b> None</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |

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| <b>Programme/Class:</b> Degree                                                                                                                                                                                                                                           | <b>Year:</b> Third (3)                  | <b>Semester:</b> Sixth (VI) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                            |                                         |                             |
| <b>Couse Code:</b> B100602T                                                                                                                                                                                                                                              | <b>Course Title:</b> Food Biotechnology |                             |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                   |                                         |                             |
| After successful completion of the course, student will be able to:                                                                                                                                                                                                      |                                         |                             |
| <ul style="list-style-type: none"><li>• understand the history and evolution of food technology and processing.</li><li>• understand the importance microorganisms in food preservation</li><li>• learn various food processing and preservation technologies.</li></ul> |                                         |                             |

| <b>Credits: 4</b>                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Core Compulsory</b>                                |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| <b>Maximum Marks: 100</b><br>(75(UE)+25(CIE))                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Minimum Passing Marks: As per University norms</b> |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                       |
| <b>Unit</b>                                                                         | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>No. of Lectures</b>                                |
| <b>I</b>                                                                            | <b>Introduction to Food Biotechnology</b> <ul style="list-style-type: none"> <li>• Historical Background of Food technology</li> <li>• Traditional fermented foods (meat, fish, bread, sauerkraut, soy bean, coffee, cocoa, tea)</li> <li>• Importance, global trends, codex guidelines, nutritional labelling in India, FSSAI guidelines</li> <li>• Improvements through Biotechnology (e.g. Golden Rice, Potato, Flavr Savr Tomato etc.)</li> </ul> | 7                                                     |
| <b>II</b>                                                                           | <b>Enzymes in Food Industry:</b> <ul style="list-style-type: none"> <li>• Carbohydrases</li> <li>• Proteasase</li> <li>• Lipases</li> <li>• Modification of food using enzymes:</li> <li>• Role of endogenous enzymes in food quality,</li> <li>• Enzymes use as processing aid and ingredients</li> </ul>                                                                                                                                            | 8                                                     |
| <b>III</b>                                                                          | <b>Food Fermentations:</b> <ul style="list-style-type: none"> <li>• Common fermented foods - Cheese, Butter, Yoghurt, fermented/condensed milk and kefir.</li> <li>• Alcoholic beverages (Beer, Wine, Whisky),</li> <li>• Sauerkraut, Pickles, Soy products, Tea, coffee etc.</li> </ul>                                                                                                                                                              | 7                                                     |
| <b>IV</b>                                                                           | <b>Food preservation:</b> <ul style="list-style-type: none"> <li>• Food adulteration and prevailing food standards in India.</li> <li>• Source of microorganisms in milk and their types.</li> <li>• Microbiological examination of milk (standard plate count, direct microscopic count, reductase and phosphatase test).</li> <li>• Dehydration and pasteurization of milk.</li> </ul>                                                              | 7                                                     |
| <b>V</b>                                                                            | <b>Value addition products:</b> <ul style="list-style-type: none"> <li>• Value addition products like High Fructose Syrup, Invert Sugars etc. SCPs ( e.g. Spirulina, Yeast etc.) as food supplements,</li> <li>• Edible fungus: Mushrooms. Potential of Probiotics.</li> <li>• Flavour enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products.</li> </ul>          | 7                                                     |
| <b>VI</b>                                                                           | <b>Vitamins and Minerals:</b> <ul style="list-style-type: none"> <li>• Importance of Vitamins and their supplementation in foods and feedstock.</li> <li>• Food preservation and storage. Food Processing</li> <li>• Important minerals and their function in body and deficiency conditions</li> </ul>                                                                                                                                               | 7                                                     |

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals;</li> </ul>                                                                                                                                                                                                                                                                                                                                                                 |   |
| <b>VII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Growth of microorganisms in food:</b> <ul style="list-style-type: none"> <li>Intrinsic and extrinsic factors.</li> <li>Food Spoilage (microbial and non-microbial) Control mechanisms of food spoilage: Physical and Chemical.</li> <li>Microbial spoilage of food and factors affecting them: Spoilage of various kinds of foods: fish, meat, poultry, sea foods, bread and dairy products).</li> <li>Food adulteration and prevailing food standards in India.</li> <li>Indicator Microorganisms: As an indicator of good quality</li> </ul> | 8 |
| <b>VIII</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Food and water borne diseases:</b> <ul style="list-style-type: none"> <li>Gastroenteritis, Diarrhoea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Dental Infections, etc.</li> <li>Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc.</li> <li>Detection of food-borne pathogens.</li> </ul>                                                                                                                                                                                                             | 9 |
| <p style="text-align: center;"><b>Suggested Reading</b></p> <ol style="list-style-type: none"> <li>Ray B and Bhunia A. 2008. <b>Fundamental Food Microbiology</b>, 4th Ed., CRC press, Taylor and Francis Group, USA.</li> <li>Martin RA and Maurice OM. 2008. <b>Food Microbiology</b>, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK.</li> <li>James M J.. 2000. <b>Modern Food Microbiology</b>, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.</li> <li>Frazier WC, and Westhoff DC. <b>Food Microbiology</b>. Fourth edition, MacGraw Hills publication</li> <li>Lopez GFG, Canaas G, Nathan EV. <b>Food Sciences and Food biotechnology</b>.</li> <li>Adams AR, and Moss MO. <i>Food Microbiology</i>. Third edition, Royal Society of Chemistry publishing .</li> <li>Hohn T and Leisinger KM. <b>Biotechnology of Food Crops in Developing Countries</b>.</li> <li>Doyle MP, Beuchat LR and Montville TJ. <b>Food Microbiology Fundamentals and Frontiers</b>. ASM Press.</li> <li>Schwartzberg HG, Rao MA. (Eds.) <b>Biotechnology and Food Process Engineering</b> .</li> </ol> <p><b>Course books published in Hindi must be prescribed by the University/College</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |
| <b>Suggested link</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |
| <p style="text-align: center;"><b>Suggested link</b></p> <ul style="list-style-type: none"> <li><a href="https://ocw.mit.edu/courses/linguistics-and-philosophy/24-03-good-food-ethics-and-politics-of-food-spring-2017/lecture-notes/MIT24_03S17_lec24.pdf">https://ocw.mit.edu/courses/linguistics-and-philosophy/24-03-good-food-ethics-and-politics-of-food-spring-2017/lecture-notes/MIT24_03S17_lec24.pdf</a></li> <li><a href="https://ocw.mit.edu/courses/linguistics-and-philosophy/24-03-good-food-ethics-and-politics-of-food-spring-2017/lecture-notes/MIT24_03S17_lec20.pdf">https://ocw.mit.edu/courses/linguistics-and-philosophy/24-03-good-food-ethics-and-politics-of-food-spring-2017/lecture-notes/MIT24_03S17_lec20.pdf</a></li> <li><a href="https://www.rug.nl/research/irees/research/edulink-fsba/fsba-course-modules/fsba-module-2-unit-3-notes-english.pdf">https://www.rug.nl/research/irees/research/edulink-fsba/fsba-course-modules/fsba-module-2-unit-3-notes-english.pdf</a></li> <li><a href="https://foodinsight.org/wp-content/uploads/2003/03/Biotech-Guide.pdf">https://foodinsight.org/wp-content/uploads/2003/03/Biotech-Guide.pdf</a></li> <li></li> </ul>         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |

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| <b>Suggested Digital platform/Web link</b>                                                                                                                                                         |
| <b>Course prerequisite</b><br>To study this course, student must have passed semester V.                                                                                                           |
| <b>Suggested Continuous Internal Evaluation (CIE) methods</b><br><b>Total marks:</b> 25<br>10 marks for Test<br>10 marks for presentation along with assignment<br>05 marks for Class interactions |
| <b>Further Suggestions:</b> None                                                                                                                                                                   |

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| <b>Programme/Class:</b> Degree                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Year:</b> Third (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Semester:</b> Sixth (VI) |
| <b>Subject:</b> Biotechnology                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |
| <b>Couse Code:</b> B100603P                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Course Title:</b> Industrial and Environmental Biotechnology Lab                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |
| After completion of this course , students will be able to- <ul style="list-style-type: none"><li>• understand various methods of screening of industrially important microorganisms from different sources.</li><li>• understand the working of small scale fermenter and also determine the aeration efficiency of the fermenter</li><li>• understand the technique of immobilization of cells like yeast and E.coli.</li></ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |
| <b>Credits:</b> 2                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Core Compulsory</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                             |
| <b>Maximum Marks:</b> 100<br>(75(UE)+25(CIE))                                                                                                                                                                                                                                                                                                                                                                                     | <b>Minimum Passing Marks:</b> As per University norms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-4</b>                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Topic</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>No. of Lectures</b>      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1. Calculation of bacterial growth curve.<br>2. Calculation thermal death point (TDP) of a microbial sample.<br>3. Production and analysis of ethanol.<br>4. Production and analysis of amylase..<br>5. Production and analysis of lactic acid.<br>6. Isolation of industrially important microorganism from natural resource.<br>7. Calculation of Total Dissolved Solids (TDS) of water sample.<br>8. Calculation of BOD of water sample.<br>9. Calculation of COD of water sample.<br>10. Bacterial Examination of Water by MPN Method. | 60                          |
| <b>Suggested Reading</b>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |
| 1. Glazier AN and Nikaido H (2007).Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge University Press.                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |

2. Casida LE (2019) **Industrial Microbiology**. Second Edition, New Age International Publisher.
3. Stanbury P F and Whitaker, A. (2010). **Principles of Fermentation Technology**. Oxford: Pergamon Press
4. Crueger W and Crueger A (2002) Crueger's Biotechnology: **A Textbook of Industrial Microbiology**. Third Edition, Panima Publishing Corp., New Delhi.
5. Blanch H W and Clark D S. (1997). **Biochemical Engineering**. New York: M. Dekker.
6. Bailey J E and Ollis D F. (1986). **Biochemical Engineering Fundamentals**. New York: McGraw-Hill.
7. Richard HB, Julian ED, Arnold LD. (2010) **Manual of Industrial Microbiology and Biotechnology**, 3<sup>rd</sup> Edition
8. Thakur IS. (2011) **Environmental Biotechnology basic concepts and applications**. I. K. International Publishing House Pvt. Limited
9. Evans GM and J. C. Furlong (2003). **Environmental Biotechnology: Theory and Applications**. Wiley Publishers.
10. Scragg A., (2005) **Environmental Biotechnology**. Pearson Education Limited.
11. Srinivas TR (2008). **Environmental Biotechnology**. New Age International Pvt. Ltd.

**Course books published in Hindi must be prescribed by the University/College**

**Course prerequisite**

To study this course, student must have passed semester V.

**Suggested Continuous Internal Evaluation (CIE) methods**

**Total marks: 25**

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

**Further Suggestions: None**